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WATER USE IN THE UPPER KOOTENAY RIVER BASIN

PREPARED BY

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Inland Waters
Pacific and Yukon Region
Vancouver, B.C.

ENVIRONMENT CANADA
CONSERVATION AND PROTECTION
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ABSTRACT

Water use in the Upper Kootenay River Basin is estimated by economic sector and sub-basin. The water use estimates, when combined with water quantity and quality information, provide a data base for long-term water demand forecasting and water resource planning.

Information sources include population, agricultural and industrial data from federal, provincial and municipal agencies, private sector interviews and field work.

Annual water use in the Basin is approximately 82.9 million cubic metres. Industrial water use accounts for 44 percent of this total, with agriculture accounting for 34 percent and domestic and commercial water use 22 percent. With a major mine and pulpmill, most water use occurs in the Kimberley sub-basin. A major increase in water demand is not expected in the foreseeable future.

RESUME

L'utilisation d'eau du bassin superièure de la rivière Kootenay est estimée par secteur économique et par sous-bassin. Les estimées d'utilisation d'eau combinées avec la qualité et la quantité d'eau fournissent une banque de donnée pour la prédiction de besoin en eau et la planification de ressource d'eau à long terme.

Les informations sur la population, l'agriculture et l'industrie viennent de données d'agences fédérales, provinciales et municipales, d'entrevue avec le secteur publique et de travail sur le terrain.

L'utilisation d'eau annuelle du bassin est approximativement 82.9 millions de mètres cubes. L'industrie utilise 44 p.100 de ce montant, l'agriculture 34 p.100 et l'utilisation domestique et commerciale 22 p.100. La plupart de cette utilisation d'eau vient du sous-bassin Kimberley. On n'entrevoit pas une augmentation significative de besoin en eau dans un avenir rapproché.

TABLE OF CONTENTS

ABSTRACT 1

RESUME ii

LIST OF TABLES iv

LIST OF FIGURES v

I. INTRODUCTION
- A. Study Objectives 1
- B. Economic Sectors 1
- C. Sub-Basins 2

II. INDUSTRIAL WATER USE
- A. Introduction 4
- B. Methods for Determining Industrial Water Use. 4
- C. Mining. 5
- D. Forestry. 8
- E. Other Industrial Water Use. 12
- F. Industrial Water Use Estimates. 12

III. DOMESTIC AND COMMERCIAL WATER USE
- A. Introduction 16
- B. Population. 16
- C. Water Use Estimates 17

IV. AGRICULTURAL WATER USE
- A. Introduction. 22
- B. Livestock and Irrigation Water Requirements 22

V. INSTREAM WATER USE 28

VI. SUMMARY
- A. Total Water Use Estimates 29
- B. Water Use Forecasts 29
- C. Concluding Remarks. 31

REFERENCES 33

LIST OF TABLES

1. Sub-Basin Areas 2
2. Principal Information Sources 5
3. Mines: Coal and Hard Rock 6
4. Mines: Production and Water Use 9
5. Sawmills and Pulpmill Operations 11
6. Other Industrial Water Use 13
7. Upper Kootenay Industrial Water Use: Summary. 15
8. Sub-Basin and Basin Populations 17
9. Urban and Rural Population and Dwellings 18
10. Water Sources 17
11. Domestic Water Use Data 20
12. Water Use by Hospitals. 21
13. Water Use by Golf Courses 21
14. Number of Farms 22
15. Livestock Water Requirements. 25
16. Irrigation Water Use. 26
17. Total Agricultural Water Use. 27
18. Total Water Use in the Upper Kootenay River Basin 30
19. Population and Water Use Projections. 32

LIST OF FIGURES

1. The Upper Kootenay River Basin 3
2. Mines and Mills. 7
3. Agricultural Land Reserves and Hydro Sites 23

I. INTRODUCTION

A. Study Objectives

The objective of this study is to estimate water use in the Upper Kootenay River Basin by economic activity and sub-basin. Data sources and methodology are also identified for comparision with other water use studies. Water use information is essential for long-term water use forecasting and, when combined with water quantity and quality information, is necessary for strategic and comprehensive water resource planning.

The water use figures derived in this report are estimates and intended only as a starting point for more in-depth water use analyses. For the purposes of this study, water use estimates are generally restricted to water withdrawals from surface and groundwater sources. In most instances, it is not practical to account for return flows.

Instream water uses such as hydroelectric production, fisheries and wildlife require extensive research and are therefore beyond the scope of this study. However, a brief discussion of instream water requirements is included as their importance cannot be overlooked in water resource planning.

B. Economic Sectors

Water use estimates are classified into three major economic sectors.

1. Industrial
2. Domestic and Commercial
3. Agricultural

These categories are consistent with sectors employed in water use studies of the Similkameen, Kettle-Granby and Lower Kootenay River Basins (Canada 1985, 1986b and 1987). Instream flow requirements are discussed separately.

C. Sub-Basins

Water use estimates are determined for the Basin and its six sub-basins. The association of water use data with specific watersheds facilitates identification of competing water uses. In addition, this information will be useful in future determinations of water quality criteria and planning objectives for specific areas in the Basin.

The six sub-basins in the Upper Kootenay Basin are Fernie, Fort Steele, Canal Flats, Kimberley, Cranbrook and Lake Koocanusa (Figure 1). The sub-basins are generally comprised of aggregated watersheds, although census boundary divisions and other physiographic characteristics are also considered. Sub-basin areas, calculated from planimetering, are given in Table 1. The total area of the Upper Kootenay River Basin is approximately 19 910 square kilometres.

TABLE 1. SUB-BASIN AREAS

SUB-BASIN	HECTARES
Fernie	3 370
Fort Steele	3 230
Canal Flats	5 290
Kimberley	4 200
Cranbrook	820
Lake Koocanusa	3 000
UPPER KOOTENAY RIVER BASIN	19 910

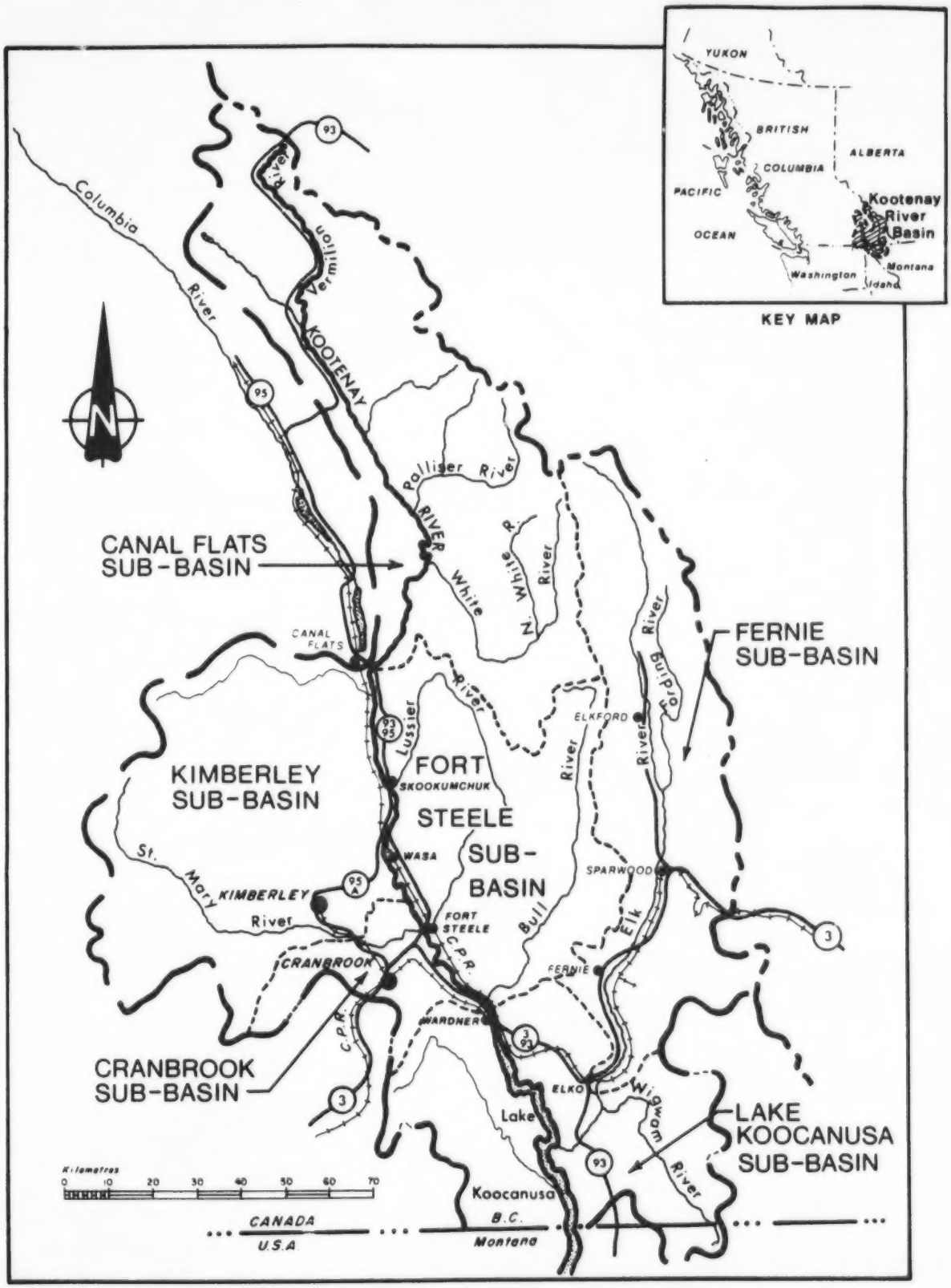

Figure 1 The Upper Kootenay River Basin

II. INDUSTRIAL WATER USE

A. Introduction

This sector includes primary resource industries such as mining and forestry as well as large-scale manufacturing, processing and other activities not included in the domestic and commercial sector.

Mining is the most important industrial activity in the Basin, in terms of value to the economy and employment. The forest industry is the next sector of importance. Several other industries are also important including concrete and ready mix operations; sand and gravel operations; water bottling and ice manufacturing industries; and, dairy, brewery and soft drink industries. The last three are distribution outlets only.

B. Methods for Determining Industrial Water Use

The method used in the study is essentially the same as in other water use studies (Canada 1985, 1986b and 1987). Major industrial water users are identified and quantities of water used by the individual firms determined.

Estimates of water use for individual firms were generally obtained by direct consultation with plant managers. In some instances, it was necessary to calculate a coefficient, or industry norm, from existing data and apply it to similar operations for which no data were available. Information sources that were used to determine the operating industries are listed in Table 2. Publication data are included in the reference list.

TABLE 2. PRINCIPAL INFORMATION SOURCES

1. Employment and Immigration Canada, 1988: The Employers Directories for Cranbrook and Fernie.

2. British Columbia Ministry of Environment, 1988: Water Licensing Data.

3. British Columbia Ministry of Energy, Mines and Petroleum Resources, 1988: Current Mining Operations.

4. British Columbia and Yukon Chamber of Mines, 1988: The Mines Employment Directory.

5. B.C. Telephone, 1988: Directories for Cranbrook, Kimberley, Fernie, Sparwood and area.

6. Scott's Directories: Western Manufacturers 1987-1988.

7. Lockwood-Post's Directory of the Pulp & Paper and Allied Trades, 1987.

8. Direct contact with each of the active mines, main forestry operations and other sectoral activities in the Basin.

C. Mining

Mining is the major industrial activity in the Upper Kootenay River Basin contributing over $600 million per year to the economy. In 1988, there were seven operating mines in the Basin employing over 5600 workers (Table 3 and Figure 2). Six mines produce coal and are located in the Fernie sub-basin; the remaining mine, Cominco's Sullivan mine, produces lead, zinc and silver and is located in the Kimberley sub-basin.

In addition to domestic use at the mine-sites, the Basin's coal producers use water for processing ore, cleaning coal and dust control. The Sullivan mine uses water for cooling drills, as a lubricant and as a process medium in the concentrator. Concentrates are subsequently transported to the smelter at Trail.

Water use estimates were obtained from all the mining operations directly with the exception of Crowsnest Resources Ltd.'s Line Creek Mine. The latter estimate was based on average water usage per tonne of production by the other active coal mines in the area. However, since there seemed to be very little correlation between water use and

TABLE 3. MINES: COAL AND HARD ROCK

MINE NAME	COMPANY	LOCATION	MINE TYPE
Balmer Operations	Westar Mining Ltd.	near Sparwood	Metallurgical coal
Harmer Ridge	Westar Mining Ltd.	near Sparwood	Metallurigical coal
Greenhills Operations	Westar Mining Ltd.	near Elkford	Metallurgical and thermal coal
Byron Creek Collieries	Esso Resources Canada Ltd.	32 Km SE of Sparwood	Thermal coal
Fording Coal Ltd.	Fording Coal Ltd.	27 Km NE of Elkford	Metallurgical and thermal coal
Line Creek	Crowsnest Resources Ltd.	20 Km N of Sparwood	Metallurgical and thermal coal
Sullivan	Cominco Ltd.	Kimberley	Lead, zinc, silver

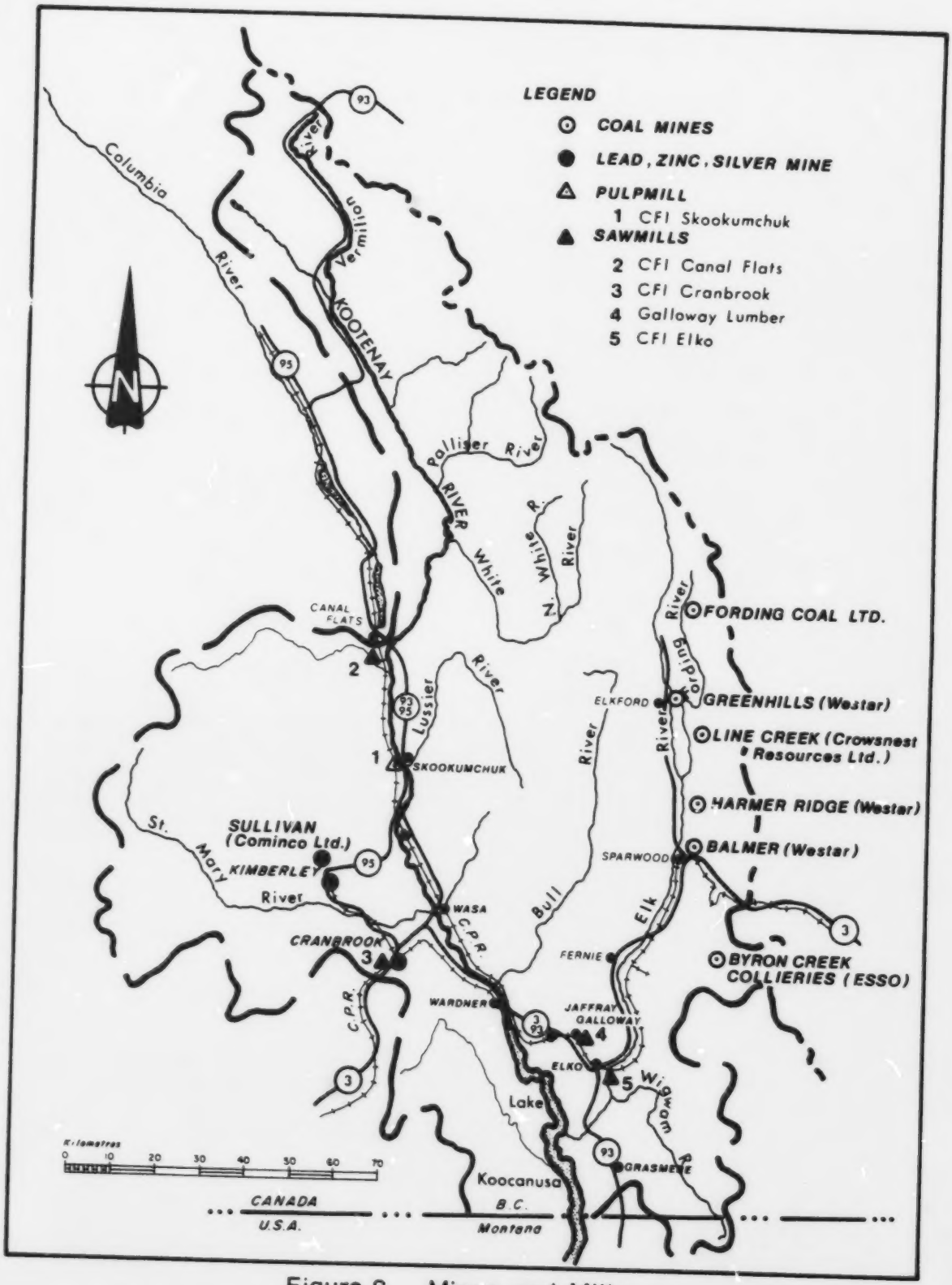

Figure 2 Mines and Mills

production, this figure can be used as a gross estimate only. Indeed, even the figures received directly from the mines are subjective as water use varies considerably with production levels and dust control requirements, which in turn are based on market and climatic variables.

As shown in Table 4, total annual water use for the mining sector is aproximately 17.1 million cubic metres per year with 9.8 million cubic metres per year of water use in the Fernie sub-basin and 7.3 million cubic metres per year in the Kimberley sub-basin.

If coal markets improve and stabilize, production levels at existing mines may increase and new mine sites open, thus increasing water use. Westar has recently submitted a proposal to Powerex, B.C.'s newly-created energy export corporation, to generate 275MW of power for export from a coal-fired thermal-electric generating plant near its Sparwood mine. The project would involve re-washing and burning of waste coal and, therefore, an additional water use in the Basin. Water use estimates are not yet available from Westar. A steel mill has also been discussed for the East Kootenay area.

D. Forestry

Forestry is the second largest employer in the Basin: nearly 2000 workers are engaged in logging operations, sawmills or in the Basin's only pulpmill. Mills are the major water users in this sector, with the pulpmill accounting for over ninety times the total water use of the sawmills.

The pulpmill, owned and operated by Crestbrook Forest Industries, is located in Skookumchuk and employs over 300 workers. There are four large sawmills in the Basin, each employing over 100 workers, and 15 smaller sawmills. Three of the large mills are owned by Crestbrook Forest Industries; these are located in Elko, with 295 employees, and Canal Flats and Cranbrook, each employing approximately 155. Galloway Lumber located on Lake Koocanusa employs 120. The 15 small operations employ over 140 in total and are scattered throughout the Basin. Figure 2 indicates locations of the pulpmill and large sawmills.

TABLE 4. MINES: PRODUCTION AND WATER USE

MINE NAME	ANNUAL PRODUCTION	# OF EMPLOYEES	WATER USE (m^3/yr)
Balmer Operations	3 483 400 tonnes	1200	5 654 733.53
Harmer Ridge	5 038 258 tonnes	1140	179 065.98
Greenhills Operations	2 435 600 tonnes	518	680 000.00
Byron Creek Collieries	800 000 tonnes	130	355 680.00
Fording Coal Ltd.	5.0 million tonnes	1050	2 188 584.21
Line Creek	1.7 million tonnes	529	710 553.81
Sullivan	3.5 million tonnes ore (250 000 t zinc concentrate) (200 000 t lead concentrate)	1100	7 300 807.42
		Total =	17 069 424.95

Although officials from each sawmill were contacted in a telephone survey, none were able to give accurate estimates of water use. However, it was indicated that the mills generally use groundwater or adjacent surface water for sanitation, cooling and lubricating saws, and watering lumber yards. Watering takes place at most mills during the summer months for dust control and fire prevention in stored lumber.

As accurate water use figures were not obtained from the telephone survey of sawmills, results from the National Industrial Water Use Survey carried out by Statistics Canada and Environment Canada in 1981 were used (Canada 1981a). Survey responses were obtained from each of the large mills but only 5 of the 15 smaller mills.

An industry norm based on water use and number of employees for the five mills was calculated and applied to each small mill. An estimate of 194 gallons per employee per day was derived for the smaller mills. Thus, water use estimates for each of the smaller mills were derived by multiplying this coefficient by the number of employees. The sawmills were then aggregated into appropriate sub-basins and separate sub-basin water use totals calculated, as indicated in Table 5. Since results of the Industrial Water Use Survey are confidential, water use totals for each mill are not reported.

The water use coefficient is on the high side since many of the operations do not operate 52 weeks of the year and not all reported water use for dust control. Also, employee counts may be inflated as figures were taken from the Fernie and Cranbrook Employers Directories which reflect the total number of T4 slips issued and do not compensate for casual or part-time employees.

However, despite erring on the high side, water use by the sawmill sector is relatively insignificant. The pulpmill is the major water user at 19.3 million cubic metres per year according to the telephone survey, compared to the forest industry total of 19.5 million cubic metres per year. Most of the pulpmill's water is returned to the river system after treatment.

Water use is not expected to increase in the forestry sector as actual timber harvesting is projected to reduce by up to 14 percent over the next decade to achieve a sustainable yield; however, the Basin's

TABLE 5. SAWMILLS AND PULPMILL OPERATIONS

MILL	LOCATION	# OF EMPLOYEES	
SUB-BASIN: FERNIE, FORT STEELE AND CANAL FLATS		TOTAL WATER USE:	127 292 m^3/yr
Cranbrook Forest Ind.	Canal Flats	155	
Eyford	Wasa	3	
Crestbrook Forest Ind.	Elko	295	
Crow Post & Wood Ltd.	Sparwood	12	
Triple A Lumber Ltd.	Elkford	6	
SUB-BASIN: KIMBERLEY		TOTAL WATER USE:	19 301 687 m^3/yr
Crestbrook Forest Ind. (pulpmill)	Skookumchuk	300	
Fabro Lumber	Kimberley	22	
Stewarts Mill	Kimberley	8	
SUB-BASIN: CRANBROOK		TOTAL WATER USE:	27 987 m^3/yr
Crestbrook Forest Ind.	Cranbrook	154	
Bear Lumber Ltd.	Cranbrook	5	
D&E Pighin	Cranbrook	1	
G&B Logging	Cranbrook	1	
Harold's Lumber	Cranbrook	22	
Lawrence Shubert	Cranbrook	30	
Savarie Wood Ltd.	Cranbrook	8	
SUB-BASIN: LAKE KOOCANUSA		TOTAL WATER USE:	53 718 m^3/yr
Galloway Lumber	Galloway	120	
DD Lumber	Galloway	5	
Lightborn & Fahselt	Jaffray	5	
McDonald Ranch & Lumber	Grasmere	10	
Roy Sinclair	Grasmere	4	
	TOTAL UPPER KOOTENAY BASIN WATER USE:		19 510 684 m^3/yr

mills will probably modify plant operations to accommodate smaller diameter logs so their production is not expected to decrease.

E. Other Industrial Water Use

There are seven concrete firms in the Basin, a water bottling company and an ice manufacturer that all use appreciable amounts of water.

Of the seven concrete operations in the Basin, five were able to supply useful information as to water use. One of the two remaining firms had just started operations and had no production data to date; the other's water use was negligible as it purchases concrete and water needs are supplied by contractees on site and would therefore be included in domestic or municipal totals.

The five companies that responded to our telephone survey were not metered but were able to provide an estimate of water use for 1987. Most of these companies are on a municipal water supply with the exception of Garrett Ready Mix which obtain their supply from the Elk River and Trikon Precast which is supplied by groundwater. Total water use by the concrete industry is estimated at 3531.97 cubic metres per year.

Canadian Aqua Blue Water Inc., Cranbrook, produces bottled drinking water and has seven employees. Their water supply is from groundwater. The company operates an average of 16 hours per week using 400 gallons per hour for an estimated water use of 6400 gallons per weekly or 1512.88 cubic metres per year.

Rocky Mountain Ice Company, also located in Cranbrook, manufactures packaged ice on a seasonal basis and employs two to four workers. Their estimated water use, based on one ice machine operating 24 hours per day all year and two machines operating for two months of the year, is 187,366.67 gallons per year or 851.75 cubic metres per year.

The water use estimates for the above industries are summarized by sub-basin in Table 6 and totals 5896.6 cubic metres per year.

F. Industrial Water Use Estimates

At 19.5 million cubic metres per year, forestry is the largest

TABLE 6. OTHER INDUSTRIAL WATER USE

COMPANY	INDUSTRY TYPE	NUMBER OF EMPLOYEES	TOTAL WATER USE (m^3yr)
CRANBROOK SUB-BASIN		TOTAL WATER USE:	5105.83
Salanski Contracting	Concrete	4	681.89
Louis Salvador & Son	Concrete	6	1350.15
Trikon Precast	Concrete	5	709.16
Canadian Aqua Blue Water Inc.	Water Bottling	7	1512.88
Rocky Mountain Ice Co.	Ice Manufacturer	2-4	851.75
FERNIE SUB-BASIN		TOTAL WATER USE:	790.77
Den Ral Concrete	Concrete	3	312.54
Garrett Ready Mix	Concrete	3	478.23
		TOTAL UPPER KOOTENAY WATER USE:	5896.6

industrial water user in the Basin; Crestbrook Forest Industries' pulpmill in Skookumchuk accounts for most of the water use in this sector. Mining is the next important sector at 17.1 million cubic metres per year with Cominco's lead, zinc and silver mine accounting for nearly as much water use as the six coal mines combined. Other industrial activities account for a relatively small portion of industrial water use: the five concrete firms, ice manufacturer and water bottling company account for only 6000 cubic metres per year. Thus, total industrial water use in the Upper Kootenay River Basin is approximately 36.6 million cubic metres per year.

A summary of industrial water use by sub-basin and industry is provided in Table 7. The Fernie, Canal Flats and Fort Steele sub-basins are aggregated to retain confidentiality of responses to the 1981 National Industrial Water Use Survey of regional sawmills.

TABLE 7. UPPER KOOTENAY INDUSTRIAL WATER USE: SUMMARY

SUB-BASIN	INDUSTRY	WATER USE (m^3/yr)	TOTAL WATER USE (m^3/yr)
Fernie, Fort Steele & Canal Flats	Forestry -2 large sawmills -3 small sawmills	127 292.0	9 896 700.3
	Mining -6 coal mines	9 768 617.5	
	Other -2 concrete firms	790.8	
Kimberley	Mining -lead/zinc mine	7 300 807.4	26 602 494.4
	Forestry -pulpmill -2 small sawmills	19 301 687.0	
Cranbrook	Forestry -1 large sawmill -6 small sawmills	27 987.0	33 092.8
	Other -3 concrete firms -ice manufacturer -water bottling co.	5 105.8	
Lake Koocanusa	Forestry -1 large sawmill -4 small sawmills	53 718.0	53 718.0
TOTAL UPPER KOOTENAY RIVER BASIN INDUSTRIAL WATER USE:			36 586 005.5

III. DOMESTIC AND COMMERCIAL WATER USE

A. Introduction

Domestic water use includes both urban and rural water users. Commercial water uses, such as small-scale manufacturing and local service industries, are included in the urban category since these activities generally use municipal water supplies and disaggregation from municipal data is difficult. Furthermore, domestic water use figures are based, to a large part, on population and it is expected that commercial water use parallels population change to a certain extent.

Significant urban water use also occurs by hospitals, golf courses and municipal parks; these are discussed separately although their water use totals, as with commercial uses, are included in the urban water use totals.

B. Population

Population statistics are derived from the 1986 Census of Canada that reports population by enumeration area (EA) (Canada 1987b). In two cases, EA's overlap sub-basin boundaries: between Canal Flats and Fort Steele and between Canal Flats and Kimberley.

In these cases, accurate sub-basin population estimates were obtained by tabulating the number of structures in each EA from planimetric maps. This number was compared to the habitable dwelling count from the 1986 census and a ratio of habitable structures for each EA was calculated. A second count was made to determine how many of these structures were in each of the overlapping areas in each sub-basin and an estimate of the number of these expected to be habited was made using the above ratio. From the census data, an estimate of average population per dwelling in each EA was obtained. The two estimates were multiplied to determine the population of the overlapped areas. The same methods were employed to

determine the population of each sub-basin. The total population of the Upper Kootenay River Basin, according to the 1986 census, is 47,201; 75 percent of the population live in the Cranbrook and Fernie sub-basins (Tables 8 & 9).

TABLE 8. SUB-BASIN AND BASIN POPULATIONS

SUB-BASIN	POPULATION
Fernie	14,956
Fort Steele	864
Canal Flats	918
Kimberley	8,061
Cranbrook	20,613
Lake Koocanusa	1,789
UPPER KOOTENAY RIVER BASIN	47,201

C. Water Use Estimates

Water use estimates are categorized as urban or rural to differentiate between water consumption figures in commercialized areas and the frequently lower rural domestic consumption. The cities of Cranbrook, Kimberley and Fernie, as well as the districts of Elkford and Sparwood, are included in the urban water use category (Figure 1). These communities obtain their water from both groundwater and adjacent surface water sources (Table 10). The remainder of the Basin's population is considered rural.

TABLE 10. WATER SOURCES

COMMUNITY	WATER SOURCE
Cranbrook	Creeks, two town wells
Kimberley	Creeks, town well
Fernie	Fairy Creek
Sparwood	Two town wells and two reservoirs
Elkford	Boivin Creek and groundwater wells

TABLE 9. URBAN AND RURAL POPULATION AND DWELLINGS

SUB-BASIN	REGION	POPULATION	DWELLINGS	POP/DWELL. RATIO
Fernie	Urban: District of Sparwood	4,540	1,546	2.94
	District of Elkford	3,187	1,051	3.03
	City of Fernie	5,663	2,011	2.82
	Urban Totals	13,390	4,608	2.93
	Rural: Unincorporated Areas	1,566	526	2.98
	Population and Dwelling Totals	14,956	5,134	2.96
Fort Steele	Rural: Unincorporated Areas	643	239	2.69
	Wasa	221	75	2.95
	Population & Dwelling Totals	864	314	2.75
Canal Flats	Rural: Unincorporated Areas	111	48	2.31
	Canal Flats	807	272	2.97
	Population & Dwelling Totals	918	320	2.87
Kimberley	Urban: City of Kimberley	6,732	2,612	2.58
	Rural: Unincorporated Areas	1,329	461	2.88
	Population & Dwelling Totals	8,061	3,073	2.62
Cranbrook	Urban: City of Cranbrook	15,893	5,734	2.77
	Rural: Unincorporated Areas	4,720	1,499	3.15
	Population & Dwelling Totals	20,613	7,233	2.85
Lake Koocanusa	Rural: Unincorporated Areas	1,789	596	3.00
	Population & Dwelling Totals	1,789	596	3.00
Total Urban Population & Dwellings:		36,015	12,954	2.76
Total Rural Population & Dwellings:		11,186	3,716	2.94
Total Basin Population & Dwellings:		47,201	16,670	2.85

Most water use data were provided by the provincial Ministry of Environment (MOE) and are based on estimates supplied by the municipalities themselves. Rural water use is based on an intermediate figure taken from a range of water use values per dwelling; these figures were also provided by the provincial MOE and the Irrigation Design Manual (British Columbia 1983).

Water supplied by municipal sources for the ice manufacturer, two sawmills and three concrete firms are deducted from the urban water use totals for Cranbrook, Kimberley and Fernie to eliminate double counting.

Final water use data, both urban and rural, by sub-basin are provided in Table 11. Total urban and commercial water use in the Basin is approximately 15.0 million cubic metres per year while total rural domestic use is substantially lower at 3.1 million cubic metres per year. Most water use occurs in the Cranbrook, Fernie and Kimberley sub-basins, as reflected by their larger population bases.

Hospitals

There are four hospitals in the Basin; water use estimates are given below for each of these although the data are included in the appropriate urban totals. All data were obtained from telephone survey.

Cranbrook Regional Hospital's water use is fully metered while Fernie District Hospital and Sparwood General Hospital only meter softened water. Fernie District Hospital estimated their metered water use to be one-third of their total consumption. This hospital uses a water-cooled air conditioner explaining its much higher consumption compared to Cranbrook Hospital. Figures for Sparwood General Hospital were based on Fernie's average number of gallons of water used per bed per day coefficient, as their operations are similar. Kimberley and District Hospital's water use figures were based on Cranbrook's average usage.

Thus the figures below are only rough estimates but do provide a general idea of water use by the regional hospitals.

TABLE 11. DOMESTIC WATER USE DATA

SUB-BASIN	REGION	DWELLINGS	WATER USE (m^3/yr)
Fernie	Rural: Unincorporated Areas	526	389 758.3
	Urban: District of Sparwood	1,546	896 879.2
	District of Elkford	1,051	1 983 578.9
	City of Fernie	2,011	4 091 018.1
	Sub-Basin Totals	5,134	7 361 234.5
Fort Steele	Rural: Unincorporated Areas	239	206 430.4
	Wasa	75	64 779.4
	Sub-Basin Totals	314	271 209.8
Canal Flats	Rural: Unincorporated Areas	48	41 458.8
	Canal Flats	272	234 933.3
	Sub-Basin Totals	320	276 392.1
Kimberley	Urban: City of Kimberley	2,612	2 167 566.5
	Rural: Unincorporated Areas	461	341 594.3
	Sub-Basion Totals	3,073	2 509 160.8
Cranbrook	Urban: City of Cranbrook	5,734	5 889 178.9
	Rural: Unincorporated Areas	1,499	1 294 724.3
	Sub-Basin Totals	7,233	7 183 903.2
Lake Koocanusa	Rural: Unincorporated Areas	596	514 780.3
	Sub-Basin Totals		
Urban Totals		12,954	15 028 221.6
Rural Totals		3,716	3 088 459.1
Upper Kootenay River Basin Totals		16,670	18 116 680.7

Notes:

Rural Water Use Calculation Based on Climatic Zones

Temperate	Intermediate
90 Days @ 1200 gal/dwelling	1500 gal/dwelling
275 Days @ 200 gal/dwelling	200 gal/dwelling

(B.C. 1983 and B.C. 1985).

TABLE 12. WATER USE BY HOSPITALS

HOSPITAL	NUMBER OF BEDS	WATER USE (m^3/yr)
Cranbrook Regional Hospital	130	28 332
Fernie District Hospital	66	29 713
Sparwood General Hospital	27	12 155
Kimberley and District Hospital	68	18 066
TOTAL HOSPITAL WATER USE:		88 266

Golf Courses

There are four golf courses in the Basin all of which draw water from municipal sources. Since their water use is significant during the summer, water use estimates have been calculated. As with hospitals, these figures are included in the urban water use totals (Table 11). The greenskeeper from each course was contacted personally. Cranbrook Golf Course is now metered and its water use figures provide the average per day per head usage for the other courses, although there will be a variation between courses.

TABLE 13. WATER USE BY GOLF COURSES

GOLF COURSE	IRRIGATED ACRES(HECTARES)	HEADS	SEASON DAYS	WATER USE (m^3/yr)
Cranbrook Golf Course	85 (34)	320	180	226 451.6
Kimberley Golf Course	60 (24)	501	90	184 109.8
Fernie Golf Course	40 (16)	400	153	227 296.0
Sparwood Golf Course	35 (14)	168	77	55 642.1
TOTAL GOLF COURSE WATER USE:				693 499.5

Municipal Parks

Municipal parks in Kimberley and Cranbrook are also irrigated in the summer months and contribute significantly to seasonal water use demands. Using the range of values for lawn watering from the Irrigation Design Manual, Cranbrook's municipal parks, with 66 irrigated acres (27 hectares), use 513 675 to 589 374 cubic metres per year of water and Kimberley, with 19 irrigated acres (8 hectares), uses 122 107 to 144 308 cubic metres per year of water. Again, these figures are already included in the urban water use totals for Kimberley and Cranbrook.

IV. AGRICULTURAL WATER USE

A. Introduction

Agriculture is less significant to the Basin's economy than mining or forestry, contributing just over $7 million annually in production values, and accordingly uses significantly less water. Cattle ranching is the dominant activity due to geographic and climatic constraints, although field crops such as hay and alfalfa, specialty items such as honey, hothouse vegetables and nurseries, and several dairy and poultry farms near Fernie and Sparwood supply a portion of local market demands. According to the 1986 Census of Agriculture, there are 306 farms in the Basin, down from 402 in 1981 (Canada 1987a). Table 14 indicates the number of farms per sub-basin and Figure 3 shows designated Agricultural Land Reserves in the Basin.

TABLE 14. NUMBER OF FARMS

SUB-BASIN	NO. OF FARMS
Fernie	48
Fort Steele	43
Canal Flats	8
Kimberley	52
Cranbrook	81
Lake Koocanusa	74
UPPER KOOTENAY BASIN	306

Cattle ranching or beef production provides an area of potential opportunity; however, it is unlikely that the Basin's agricultural sector will expand significantly. Competition for rangeland from non-agricultural uses and the continuing trend towards hobby farms are limiting factors.

B. Livestock and Irrigation Water Requirements

Livestock data, such as type and population in each sub-basin, were

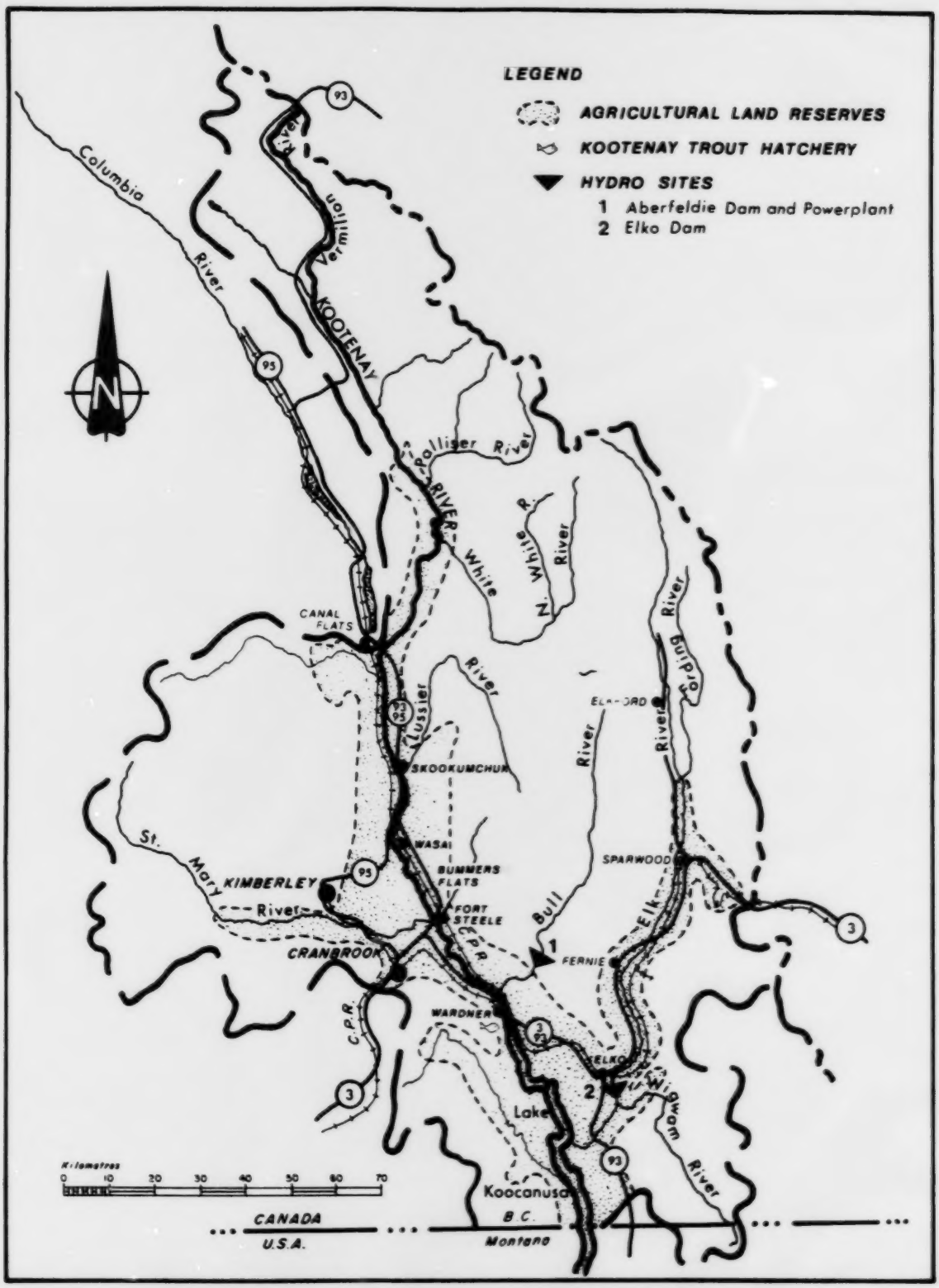

Figure 3 Agricultural Land Reserves and Hydro Sites

obtained from the 1986 Census of Agriculture (Canada 1987a). These data were multiplied by a water use coefficient to determine the amount of water required by each livestock type in each sub-basin. Table 15 provides a summary of this information as well as total water use requirements for livestock in each sub-basin and the Basin.

The water use coefficient for each livestock type was estimated following discussions with the District Horticulturist and the federal Atmospheric Environment Service. The District Horticulturist provided estimates of water use per day for a range of temperatures for each livestock type (British Columbia 1988a). Degree-day data for various locations in the Basin were provided by the federal Atmospheric Environment Service (Canada 1988c). Then, the number of days in each sub-basin in specified temperature ranges were multiplied to determine water use by each livestock type.

Previous water use studies have used coefficients for livestock derived by the Prairie Provinces Water Board; however, the Board's coefficients are based on a hotter, drier climate and do not adequately represent the Upper Kootenay River Basin.

A similar method was employed to determine water use for agricultural crops. Cultivated areas were identified from air photos and cross-checked by field survey to determine crop type, irrigated and non-irrigated acreage and any new activity. The total agricultural area observed to be irrigated was 14 122.5 acres or 5 715.2 hectares. The Fernie and Canal Flats sub-basins had the least amount of agricultural activity. Some difficulty was experienced in determining if some crops were under irrigation as they had already been harvested. Others that looked dry, were reported to have been irrigated at least once. However, a range of water use for each crop type in two representative climatic zones was provided by the District Horticulturist and the irrigated hectares were multiplied by this coefficient (Table 16) (British Columbia 1988a).

Based on the above assumptions and calculations, livestock use 255 784 cubic metres per year of water and irrigation accounts for 27.9 million cubic metres per year of water. Total agricultural water use by sub-basin is summarized in Table 17; total water use for agriculture in the Upper Kootenay River Basin is estimated at 28.2 million cubic metres per year.

TABLE 15. LIVESTOCK WATER REQUIREMENTS

A. LIVESTOCK POPULATIONS BY SUB-BASIN

TYPE OF LIVESTOCK	FERNIE	FT. STEELE	CANAL FLATS	KIMBERLEY	CRANBROOK	LAKE KOOCANUSA	TOTAL
Bulls	48	95	56	35	150	122	506
Dairy Cows	9	14	0	13	19	59	114
Beef Cows	590	2,229	861	526	2,437	2,464	9,107
Dairy Heifers	0	0	0	0	0	0	0
Beef Heifers	146	285	127	36	376	327	1,297
Heifers for Slaughter	35	4	0	0	20	130	189
Steers	79	29	570	81	35	159	953
Calves	480	2,045	789	549	2,282	2,185	8,330
Pigs	0	0	0	0	718	0	78
Sheep	162	0	0	16	0	84	262
Horses, etc.	96	250	33	152	358	382	1,271
Chickens	1,172	13,021	457	1,277	2,665	994	19,586
Turkeys	141	54	0	97	183	0	475
Other Poultry	0	0	0	0	76	140	216

B. WATER USE BY SUB-BASIN
(m^3/yr)

TYPE OF LIVESTOCK	FERNIE	FT. STEELE	CANAL FLATS	KIMBERLEY	CRANBROOK	LAKE KOOCANUSA	TOTAL
Bulls	791.85	1 572.90	935.70	579.49	2 483.52	2 055.81	8 419.26
Dairy Cows	224.79	351.52	0	326.41	477.07	1 511.75	2 891.54
Beef Cows	9 733.13	36 905.17	14 386.31	8 708.89	40 348.99	41 520.52	151 603.01
Dairy Heifers	0	0	0	0	0	0	0
Beef Heifers	2 408.54	4 718.70	2 122.02	596.05	6 225.37	5 510.23	21 580.90
Heifers for Slaughter	577.39	66.23	0	0	331.14	2 190.61	3 165.36
Steers	1 303.25	480.15	9 524.04	1 341.10	579.49	2 679.29	15 907.32
Calves	1 583.70	6 771.74	2 636.34	1 817.94	7 556.54	7 362.08	27 728.33
Pigs	0	0	0	0	148.45	0	148.45
Sheep	300.22	0	0	30.04	0	164.07	494.32
Horses, etc.	1 583.70	4 139.21	551.39	2 516.64	5 927.35	6 437.03	21 155.31
Chickens	154.76	1 726.38	60.95	169.31	353.34	133.27	2 598.01
Turkeys	18.62	7.16	0	12.86	24.26	0	62.90
Other Poultry	0	0	0	0	10.08	18.77	28.85
Total Water Use	18 679.92	56 739.16	30 216.76	16 098.73	64 465.58	69 583.42	255 783.57

TABLE 16. IRRIGATION WATER USE

SUB-BASIN	IRRIGATED HAY & ALFALFA (acres/hectares)	COEFFICIENT[1] (ac. ft.)	WATER REQUIRE. (ac. Ft.)	OTHER IRRIGATED CROP LANDS (acres/hectares)	COEFFICIENT[1] (ac. ft.)	WATER REQUIREMENTS (ac. ft.)	TOTAL IRRIGATION CROP REQUIREMENTS (ac. ft./yr)	(m^3/yr)
FERNIE	327.13 (132.4)	1.25	408.91	4.65 (1.9)	1.0	4.65	439.53	542 146.18
				20.77 (8.4)	1.25	25.96		
FT. STEELE	3465.71 (1402.5)	1.67	5787.74	337.47 (136.6)	1.67	563.57	6780.67	8 363 838.22
				343.49 (139.0)	1.25	429.36		
CANAL FLATS	344.50 (139.4)	1.67	575.32	0	1.25	0	575.32	709 640.70
KIMBERLEY	1298.06 (525.3)	1.25	1622.58	60.78 (24.6)	1.25	75.98	1698.55	2 095 130.85
CRANBROOK	2682.80 (1085.6)	1.67	4480.28	1793.2 (725.7)	1.67	2994.64	7576.22	9 345 131.00
				81.04 (32.8)	1.25	101.30		
LAKE KOOCANUSA	3080.27 (1246.5)	1.67	5144.05	136.87 (55.4)	1.67	228.57	5554.86	6 851 821.43
				145.79 (59.0)	1.25	182.24		
TOTALS	11,198.47 (4531.7)		18,018.87 (22 225 945.76 m^3/yr)	2924.06 (1183.4)		4606.28 (5 681 762.6 m^3/yr)	22,625.14	27 907 708.36

[1]Table of Coefficients Based on Climatic Zones:

	TEMPERATE	INTERMEDIATE
Hay	1.25	1.67
Grain	1.00	1.25

(B.C. 1983)

TABLE 17. TOTAL AGRICULTURAL WATER USE

SUB-BASIN	LIVESTOCK (m^3/yr)	IRRIGATION (m^3/yr)	ALL AGRICULTURE (m^3/yr)
Fernie	18 679.9	542 146.2	560 826.1
Fort Steele	56 739.2	8 363 838.2	8 420 577.4
Canal Flats	30 216.8	709 640.7	739 857.5
Kimberley	16 098.7	2 095 130.9	2 111 229.6
Cranbrook	64 465.6	9 345 131.0	9 409 596.6
Lake Koocanusa	69 583.4	6 851 821.4	6 921 404.8
Basin Totals	255 783.6	27 907 708.4	28 163 492.0

V. INSTREAM WATER USE

Non-consumptive water uses are an essential consideration in all water allocation decisions. While difficult to quantify, minimum streamflows and lake levels are often needed to meet many resource management objectives. This is certainly the case in the Upper Kootenay River Basin where hydroelectric production, fisheries and recreation are important non-consumptive water uses. This study does not attempt to quantify the water needs of these sectors, but a brief description of each is included.

B.C. Hydro operates two small hydro sites in the Basin near Fernie: Elko and Aberfeldie (Figure 3). At peak flows, Elko generates 9.6MW and Aberfeldie generates 5MW; both are run-of-the-river plants, therefore output is dependent on flow. In addition, the provincial Ministry of Environment, Water Management Branch, indicates there are 11 other water licences issued in the Basin for small hydro production; most of these are associated with sawmills or ranching operations and not connected to B.C. Hydro's transmission grid.

The provincial MOE Fish and Wildlife Branch operates the Kootenay Trout Hatchery approximately 50 kilometres southeast of Cranbrook. Based on information provided by the Hatchery Manager, it was calculated that the hatchery requires approximately 5.3 million cubic metres of water per year; 99 percent of this is for fish culture while the remaining one percent is for domestic use, aquaria in the visitor showroom, lawn irrigation and fire protection. All water is returned to Norbury Creek.

There are also 18 water storage licences in the Basin, according to the provincial MOE Water Management Branch. These total less than 3.7 million cubic metres per year (3000 acre-feet) and are mostly for habitat conservation purposes. The Conservation Officer in Nelson, B.C., was also able to identify species sensitive to changes in water levels in the Basin. These include osprey, whitetail deer and muskrats. In addition, Bummers Flats is an important waterfowl staging and breeding area (Figure 3); therefore, preservation of this wetland habitat is important.

VI. SUMMARY

A. Total Water Use Estimates

Consumptive water use for each sector and sub-basin is summarized in Table 18. The Kimberley sub-basin (pop. 8000) uses the most water due to its high industrial water demands. Fernie (pop. 15,000) and Cranbrook (pop. 20,000) are next with mining dominating in the Fernie sub-basin and agriculture in the Cranbrook sub-basin; both of these sub-basins also have significant domestic and commercial water use. Total annual water use in the Upper Kootenay River Basin is approximately 82.9 million cubic metres per year.

Industrial water use accounts for 44 percent of the Basin's total water use. Crestbrook Forest Industry's pulpmill and Cominco's lead, zinc and silver mine contribute to Kimberley sub-basin's high industrial water use (72 percent of total industrial water use). Fernie sub-basin's six coal mines are major industrial users in that sub-basin.

Although agriculture is not a major economic activity in the Basin, it still accounts for a significant portion of the water use total (34 percent). As would be expected, most agricultural water use occurs in the three least-mountainous sub-basins: Cranbrook, Fort Steele and Lake Koocanusa. Irrigation of forage crops such as hay and alfalfa is the major water requirement in the agricultural sector.

Domestic and commerical water use generally parallels population although the Fernie sub-basin uses more water than Cranbrook. There are three small urban centers in the Fernie sub-basin, each with their own range of commercial services and amenities, compared to one urban center in the Cranbrook sub-basin; perhaps economies of scale contribute to this anomaly or perhaps Cranbrook meters their water more accurately or uses water more efficiently.

B. Water Use Forecasts

A major increase in water use in the foreseeable future is not

TABLE 18. TOTAL WATER USE IN THE UPPER KOOTENAY RIVER BASIN

SUB-BASIN	INDUSTRIAL (m^3/yr)	DOMESTIC AND COMMERCIAL (m^3/yr)	AGRICULTURE (m^3/yr)	TOTAL (m^3/yr)	PERCENT OF BASIN'S WATER USE
Fernie	9 811 839.0[1]	7 361 234.5	560 826.1	17 733 899.5	21
Fort Steele	42 430.7[1]	271 209.8	8 420 577.4	8 734 217.9	11
Canal Flats	42 430.7[1]	276 392.1	739 857.5	1 058 680.3	1
Kimberley	26 602 494.4	2 509 160.8	2 111 229.6	31 222 884.8	38
Cranbrook	33 092.8	7 183 903.2	9 409 596.6	16 626 592.6	20
Lake Koocanusa	53 718.0	514 780.3	6 921 404.8	7 489 903.1	9
Basin Total	36 586 005.6	18 116 680.7	28 163 492.0	82 866 178.2	
Percent of Basin's Water Use	44	22	34		

[1]Due to confidentiality of water use figures in the forestry sector, the industrial totals for Fernie, Fort Steele and Canal Flats reflect each sub-basin's water use in mining and other industrial activities (no others in Fort Steele and Canal Flats) plus one-third of the three sub-basins total water use for forestry.

expected, indeed, population projections indicate a decline in the next few years followed by a gradual increase to the year 2010 (Table 19). Water use forecasts have been calculated based on current water use and percent change in population per year. Population figures for the three health areas in the Basin and percent change data for the Regional District of East Kootenay were obtained from the provincial Ministry of Economic Development (1988d and 1988f).

These figures are, of course, extremely subjective as water use in the Upper Kootenay River Basin seems more dependent on industrial activity than on population. For example, the life expectancy of Cominco's lead, zinc and silver mine in Kimberley is ten years. While the closure is reflected to a degree in population forecasts, the significant water use of the mine itself has not been deducted from these totals. Similarly, life expectancies of the coal mines have not been incorporated into the figures. It is hoped that new economic developments will replace those that are phased out.

C. Concluding Remarks

The water use figures presented in this report are approximations only, to be used for gross levels of comparision among sectors and sub-basins. A more rigorous approach would be necessary before detailed water resource management decisions could be made, particularly with respect to non-consumptive or instream uses.

For additional background information on the Basin's physical and biological resources and existing and potential economic activities, refer to "Water and Related Resources in the Upper Kootenay River Basin" prepared by Environment Canada, Inland Waters and Lands, February 1988.

TABLE 19. POPULATION AND WATER USE PROJECTIONS

YEAR	FERNIE & AREA[1]	CRANBROOK[1] & AREA	KIMBERLEY[1] & AREA	AVERAGE PERCENT CHANGE[2]	BASIN POP. PROJECTION	WATER USE (m^3/yr)
1986	16,767	21,216	8652		46,635	82 866 178.2
1987	15,711	20,661	7942	- 4.58	44,314	79 070 907.2
1988	15,019	20,224	7560	- 3.07	42,803	76 643 430.4
1989	14,662	19,900	7466	- 1.46	42,028	75 524 436.3
1990	14,383	19,681	7409	- 1.08	41,473	74 708 772.4
1991	14,182	19,554	7480	- 0.39	41,216	74 417 408.2
1992	14,204	19,577	7547	0.38	41,328	74 700 199.4
1993	14,430	19,754	7610	1.11	41,794	75 529 366.6
1994	14,838	20,081	7668	1.77	42,587	76 866 236.4
1995	15,270	20,475	7700	1.88	43,445	78 311 321.6
1996	15,737	20,948	7709	2.05	44,394	79 916 703.7
1997	16,249	21,499	7695	2.22	45,493	81 690 854.5
1998	16,791	22,125	7657	2.34	46,573	83 602 420.5
1999	17,346	22,805	7595	2.38	47,746	85 592 158.1
2000	17,880	23,484	7525	2.27	48,889	87 535 100.1
2001	18,406	24,155	7449	2.17	50,010	89 434 611.7
2002	18,932	24,834	7365	2.13	51,131	91 339 568.9
2003	19,458	25,527	7267	2.09	52,252	93 248 565.9
2004	19,984	26,237	7154	2.05	53,375	95 160 161.5
2005	20,504	26,960	7031	2.01	54,495	97 072 880.7
2006	21,013	27,676	6895	1.92	55,584	98 936 680.0
2007	21,507	28,381	6750	2.0	56,638	100 915 413.6
2008	21,989	29,074	6599	1.57	57,662	102 499 785.5
2009	22,458	29,760	6442	1.68	58,660	104 221 781.8
2010	22,915	30,436	6280	1.61	59,631	105 899 752.4

1 Source: British Columbia 1988d
2 Source: British Columbia 1988f

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